International Journal of Agriculture and Food Science Technology.
ISSN 2249-3050, Volume 4, Number 7 (2013), pp. 707-712

http://www.ripublication.com/ ijafst.htm

Antioxidant and Nutritional Activity Studies of Green Leafy Vegetables

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Abstract

An investigation was carried out with nine green leafy vegetables (GLV's) with their popular varieties most commonly grown in India to determine their biochemical composition. Among leafy vegetables ascorbic acid was found maximum in Chenopod cultivar Bathua Local (60.6 mg/100 g fw.) followed by Pusa Bathua -1 (23.0 mg/100g fw.) and spinach cultivar PS-1 (51 mg/100 g fw.). Significantly high level of total carotenoids was recorded in amaranth cultivar Pusa Lal Chaulai (69.4 mg/100 g fw.) & Pusa Kiran (59.0 mg/100g fw.), however Basella cultivar Local Red and Local Green recorded low value of total carotenoids (10.2 mg/100 g). High value of CUPRAC was recorded in chenopod cultivar Bathua Local (32.7 µ moltrolax/g) and Pusa Bathua-1 (23.0 µ moltrolax/g), while FRAP was maximum in Swiss Chard Local (4.2 µ mol ascorbic acid/ g f.w). Poly phenols content of GLV's ranged from 1134 µg gallic acid equivalent (GAE)/ g of amaranth cultivar Pusa LalChaulai to 154 µg GAE/ g in case of palak cultivar Pusa Bharati. On overall basis the antioxidant capacity of leafy vegetables were in order of amaranth > chenopod > spinach > palak > fenugreek > sarson sag.

Keywords: Green leafy vegetables, carotenoids, ascorbic acid, phenolic content and antioxidant activity.

1. Introduction

Green leafy vegetables (GLV's) are rich source of vitamins such as beta carotene, ascorbic acid, folic acid and riboflavin as well as minerals such as iron, calcium and phosphorous. They also contain an immense variety of bioactive non-nutritive health promoting compounds such as antioxidants and phytochemicals, which provide health benefits beyond basic nutrition. Green leafy vegetables have long been recognized most abundant sources of protein, vitamins and minerals (Aletor *et al.*, 2002; Shukla *et al.*, 2006). Antioxidants vitamins like ascorbic acids, phenols etc. are important in human food since they function as an anticancer agent (Shibata *et al.*, 1992). Many leafy vegetables especially, amaranth, fenugreek, palak and spinach has attained commercial status and its cultivation is wide spread in India. Because of their low production cost and high yield, GLV's are considered to be one of the cheapest vegetables in the market and it could be rightly described as 'poor man's vegetables'. Seeing the potential of GLV's as a cheap source of antioxidants and other nutrients, the present study was conducted to determine the antioxidants activity of these GLV's by methanolic extracts in different systems at multiple concentrations. Total antioxidant activity assessed by Ferric reducing antioxidant power (FRAP), Cupric ion reducing antioxidant capacity (CUPRAC), total phenols, ascorbic acid, total carotenoids and dry matter contents were also analysed.

2. Materials and Methods

The present investigation was carried out at Indian Agricultural Research Institute, New Delhi situated at 28.08^0 N and 77.12^0 E with an altitude of 228.61 m. The climate is subtropical and semi-arid. 15 genotypes of 9 GLV's were grown at research farm, Division of Vegetable Science, IARI, New Delhi during November-December 2011-12 and 2012-13. The edible portion was harvested at marketable stage (60 days after sowing) and fresh leaf samples were washed under running tap water followed by double distilled water. They were drained completely, dried over filter paper and analysed for ascorbic acid, polyphenols, total carotene, antioxidant activity and dry matter. All analyses were carried out induplicate. Total carotene was determined by using acetone and petroleum ether as extracting solvents and ascorbic acid was estimated titrimetrically using 2, 6-dichlorophenol indophenol (Ranganna, 1986). Total polyphenols content in ethanol extracts was determined with Folin-Ciocalteau reagent using gallic acid as a standard (Singleton and Rossi, 1965).Cupric ion reducing antioxidant capacity (CUPRAC) was measured by the method named by a research group (Apax *et al,* 2004). Total antioxidant activity was measured by ferric reducing antioxidant power (FRAP) assay according to Benzie and Strain (1999).

3. Results and Discussion

Significant variation was observed amongst different Green leafy vegetables (GLV's) from nutritional point of view. Ascorbic acid content was found to be significantly higher in amaranth cultivar Pusa Kiran (67 mg per 100 g) followed by chenopod cultivar Local (60.6 mg/100g) and spinach cultivar PS-1 (60.6 and 51 mg/100g) than all other GLV's. The highest total carotenoids contents (TCC) was measured in amaranth cultivar Pusa Lal Chaulai (69.4 mg per 100 g fw.) followed by Pusa Kiran (59.0 mg per 100 g), however Swiss chard cultivar Local (45.0 mg/100g) and chenopod cultivar Pusa Bathua-1 (40.9 mg/100g) also recorded high value of TCC, but it was significantly lower than amaranth. Different GLV's differed significantly with respect to total phenolic contents ($P \geq 0.5$). Amaranth cultivar Pusa Lal Chaulai had significantly higher total phenolic content (1134 µg gallic acid equivalent (GAE) per g fw.) followed by Pusa Kiran (941 µg GAE per g fw.), which showed highly significant difference with other GLV's under study i.e. chenopods Local (750 µg GAE/g fw.) and Pusa Bathua-1 (647 µg GAE/g fw.).Yadav *et al*. 2013*a* and Yadav *et al*. 2013b also reported variation in total phenolic content in their study on amaranth and chenopod respectively. Therefore, it can be said that the total polyphenol content of vegetables varies widely depending on the variety of vegetable. Among all the GLV's highest antioxidant activity by CUPRAC method was found in chenopod cultivar Local (32.7 µmoltrolax per g), which was significantly higher than other GLV's (Table1). Similarly among different GLV's, high value of antioxidant activity by FRAP method was found in Swiss chard cultivar Local (4.2 µ mol ascorbic acid equivalent (AAE) per g fw.), spinach cultivar PS-1 (3.1 µ mol AAE per g fw.) and chenopod Local (2.5 µ mol AAE per g fw.). Pasko *et al*. (2009) reported antioxidant activity i.e. 3.37 mM Fe^{+2} Kg^{-1} DW by FRAP method in *Amaranthus cruentus* v. Aztec. Very high antioxidant activities were found in intensely coloured genotypes (chenopods, Swiss chard and spinach). Therefore, genotypes with coloured edible parts i.e. leaf and stem should be promoted for consumption in GLV's. It was evident from Table1 that red leaved amaranth had higher poly phenols and antioxidant activity (CUPRAC and FRAP) than green leaved.

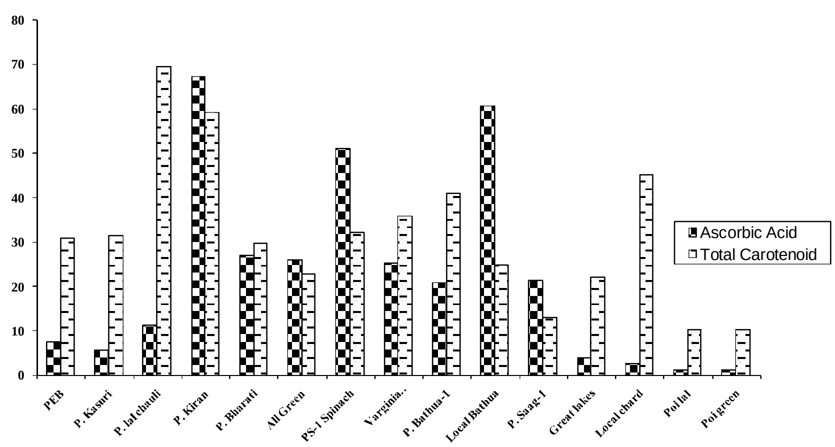

Figure 1: ascorbic acid (mg/100g) and total carotenoids (mg/100g) in different Indian Leafy vegetables (LSD =0.90 for ascorbic acid, LSD=1.4 for total carotenoids).

Table1: Cuprac, Frap, total polyphenols and dry matter contents of different green leafy vegetables. (Values are mean ± SD of 3 determinations)

S. No.	Genotype/ common name	Botanical name	Varity/type	CUPRAC (µ mol trolax /g)	FRAP (µ mol AA/ g fw.)	Phenols (µg GAE/g fw.)	Dry matter (%)
1	Methi	(Trigonella foenum graecum)	Pusa Early Bunching	12.65±0.66	0.87±0.21	302.80±0.72	12.40±0.46
2	Kasuri methi	(Trigonella corniculata)	Pusa Kasuri	10.98±0.59	0.36±0.18	417.90±0.85	11.60±0.26
3	Amaranth	(Amaranthus tricolor)	Pusa Lal Chaulai	18.60±0.62	2.27±0.21	1133.73±0.64	8.97±0.45
4	Amaranth	(Amaranthus tricolor)	Pusa Kiran	16.30±0.70	1.40±0.36	941.57±0.51	9.53±0.15
5	Palak	(Beta vulgaris var. bengalensis	Pusa Barati	8.50±0.50	1.50±0.30	154.43±0.51	6.13±0.32
6	Palak	(Beta vulgaris. var. bengalensis)	All Green	4.43±0.35	0.67±0.25	301.60±0.53	6.67±0.25
7	Spinach	(Spinacia oleracea)	PS-1(prickly seeded)	21.83±0.76	3.17±0.31	397.00±1.00	6.83±0.31
8	Spinach	(Spinacia oleracea)	Varginia Savoy (round seeded)	17.78±0.35	2.30±0.46	225.73±0.64	7.83±0.31
9	Chenopod	(Chenopodium album)	Pusa Bathua-1	23.13±0.32	1.70±0.26	647.03±0.95	10.40±0.50
10	Chenopod	(Chenopodium album)	Bathua Local	32.73±0.35	2.60±0.26	750.47±0.50	16.53±0.35
11	Sarson sag	(Brassica juncea var. rapa)	Pusa Sarson-1	5.12±0.35	0.17±0.02	234.00±1.00	13.13±0.32
12	Lettuce	(Lactuca sativa)	Great Lakes	5.86±0.41	0.06±0.03	202.47±0.50	8.50±0.40
13	Swiss chard	(Beta vulgaris var. cicla)	Local Swiss chard	16.00±1.00	4.27±0.21	201.30±1.47	22.80±0.26
14	Indian spinach or Poi	(Basella rubra)	Local Red	9.72±0.20	0.34±0.03	311.67±1.53	12.60±0.26

15	Indian spinach or Poi	(Basella alba)	Local green	9.51±0.36	0.34±0.04	475.00±1.00	12.23±0.25

Similarly Ali *et al*, (2010) reported that red-fleshed leaf cultivars of amaranth contained higher amount of pigments, total polyphenol and antioxidant activity than green-fleshed leaf cultivar. Significantly high value of dry matter (%) was recorded in Swiss chard (22.9%) followed by chenopod local (16.5%).

4. Conclusion

The results suggested that Pusa Lal Chaulai (amaranth), Bathua Local (chenopod), PS-1 (spinach), Pusa Bharati (palak) and Swiss chard local may be popularised and made available to the consumers. Based on the findings it was concluded that the amaranth, chenopod, spinach had the high antioxidant activity and could be utilized for improving the efficiency of different nutraceutical and pharmacological products. The consumption of these may play a role in preventing human diseases in which free radicals are involved such as cancer, cardiovascular diseases and aging.

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